Conference report

The Fourth Taylor Conference: New work on gold catalysts

Geoffrey Bond
9 Townfield, Rickmansworth WD3 7DD

The latest in this series of conferences took place at the University of Cardiff from 22 – 25 July 2009; it commemorates a distinguished scientist who formulated many of the basic concepts of adsorption and heterogeneous catalysis. Hugh Stott Taylor (1890-1974) was born in Liverpool, but spent his entire academic career at Princeton University; he retained his British nationality and was knighted in 1953, the year he served as President of the Faraday Society. He is best known for his Theory of the Active Centre, which states that the fraction of a catalyst's surface that is active depends on the reaction being used. He also developed the idea of Activated Adsorption of molecules that do not adsorb readily, and his laboratory was the first to prepare almost pure D_2O by electrolysis of water, and to use it for studying the mechanism of catalysed reactions. Although during his lifetime gold was not rated highly as a catalyst, he showed (1) that gold foil catalysed the equilibration of H_2 + D_2 at 600-670 K; this high temperature was needed for thermal activation of *d*-electrons to *s*-states, so that the reactants could chemisorb dissociatively. Small gold particles are now known to dissociate H_2 at room temperature (2).

In the first part of the meeting, invited speakers reviewed their recent research. C. Kiely (Lehigh University, Bethlehem PA) described the application of high-angle annular dark-field electron microscopy to the structure of Au/Fe_2O_3 catalysts, showing that gold monolayers and bilayers were present alongside larger particles; the bilayer structure showed greatest activity for CO oxidation. It is formed preferentially when precursors are dried in flowing rather than static air. Palladium-gold particles prepared by the colloidal route and supported on TiO_2 or carbon are active for the selective oxidation of H_2 to H_2O_2; this technique reveals that, although palladium may be on the outside, it is the gold core that wets the TiO_2 and binds the particle to the support. M. Haruta (Tokyo Metropolitan University) explained that gold supported on the microporous titanosilicate TS-1 when alkali-treated allowed epoxidation of propene to proceed without H_2, provided water was present (3). He also showed that Au/La_2O_3 catalysed the liquid-phase hydrogenation of benzene to cyclohexene with >70% selectivity.

The second part was given over to talks by research students and junior scientists, and in this part new work on gold catalysts was contributed by members of the Cardiff Catalysis Institute. The role of gold in moderating the palladium-catalysed oxidation of ethene with acetic acid has long been debated; J. Counsell showed that it lowers the decomposition of ethene to carbon on the Pd(111) surface. The reaction of glycerol with urea to give glycerol carbonate was shown by C. Hammond to be catalysed by Au/ZSM-5 prepared by impregnation rather than deposition-precipitation; the by-product NH_3 can be re-converted to urea by CO_2. Factors improving the selectivity of the direct synthesis of H_2O_2 were considered by J. Edwards; these include acid-washing the carbon support for PdAu particles, and the presence of protons and halide ions in the liquid phase. Finally, the addition of gold to Hopcalite ($CuMnO_x$), a commercial catalyst for CO oxidation, was shown by K. Morgan to increase surface oxygen availability and hence to promote the Mars-Van Krevelen mechanism.

This enjoyable meeting demonstrated the continued progress of gold catalysis.

References

1 R.J. Mikovsky, M. Boudart and H.S. Taylor, *J. Am. Chem. Soc.* **76** (1954) 3814
2 E. Bus, J.T. Miller and J.A. van Bokhoven, *J. Phys. Chem B* **109** (2005) 14581
3 T. Ishida, M. Nagaoka, T. Akita and M. Haruta, *Chem. Eur J.* **14** (2008) 8456

Sir Hugh S. Taylor